# New Technologies in Disinfection and Sterilization

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Disclosure: Research support from Pfizer, Merck, Clorox, GOJO, Avery Dennison, PDI

# Outline

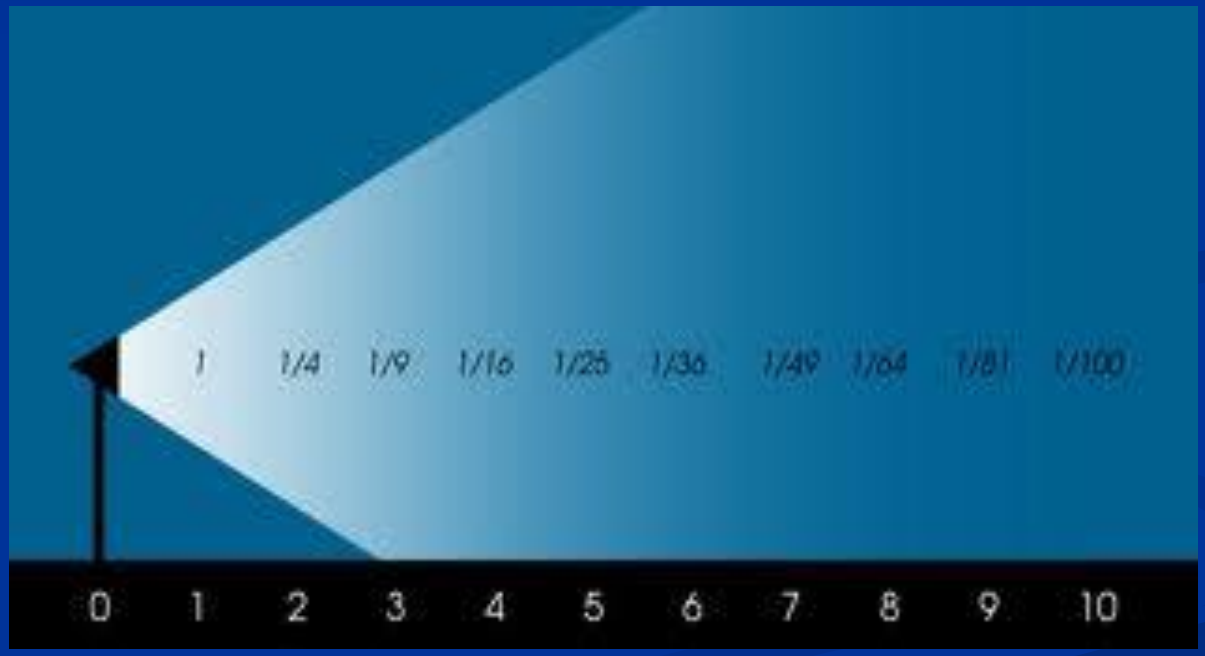
- Expanding applications of UV-C
  - Automation, proximity, UV-C by light-emitting diode (LED), low-intensity devices used while people are in the room
- Spray products
- Continuous disinfection
  - High-intensity visible light, UV-A
- New monitoring tools

# Decrease in irradiance with distance

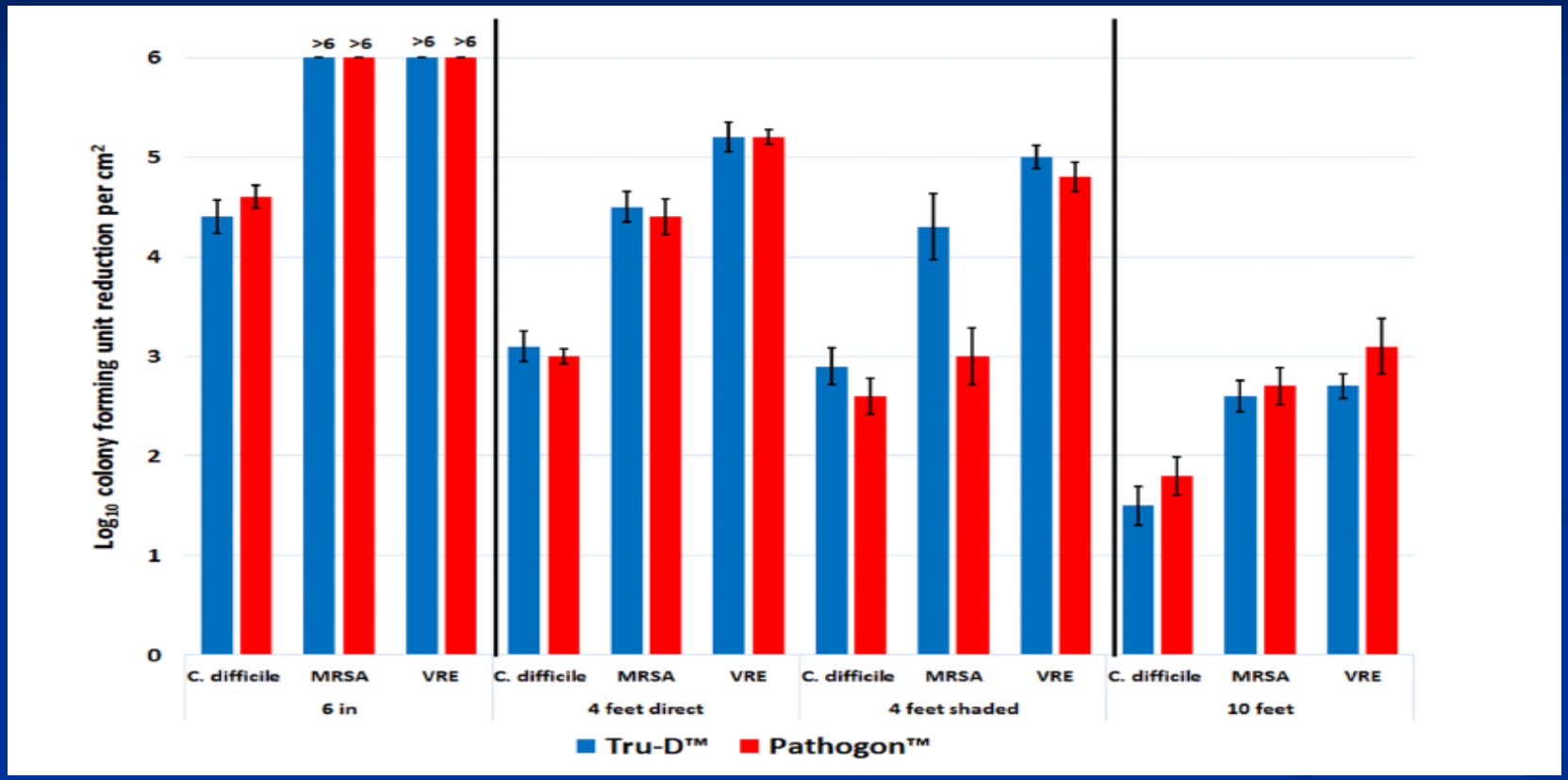
- Inverse square law: Irradiance ~1/distance $^2$

Relative irradiance

Distance



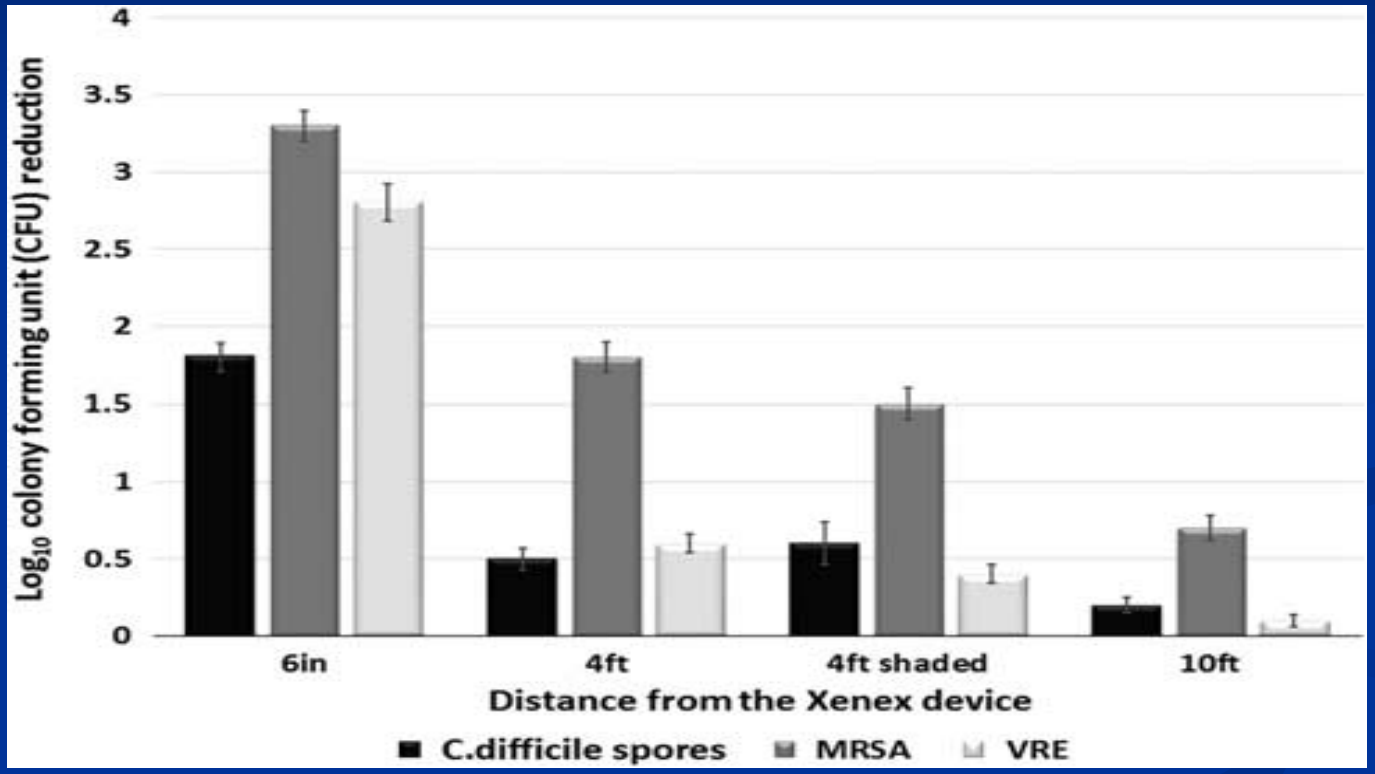
# Effect of distance and shading




Test conditions: steel carriers, inoculum spread to cover 1 $cm^2$
4 feet from device with direct exposure, 41 minutes

Nerandzic MM, et al. PLoS One 2014;9:e107444; Rutala WA, et al. ICHE 2010;31:1025-29
(~1 log less reduction in areas with indirect UV exposure)

# Effect of distance on the efficacy of a pulsed xenon UV device




Test conditions: glass slides, inoculum spread to cover 1 $cm^2$
direct exposure, 10 minutes exposure, shaded = under bedside table

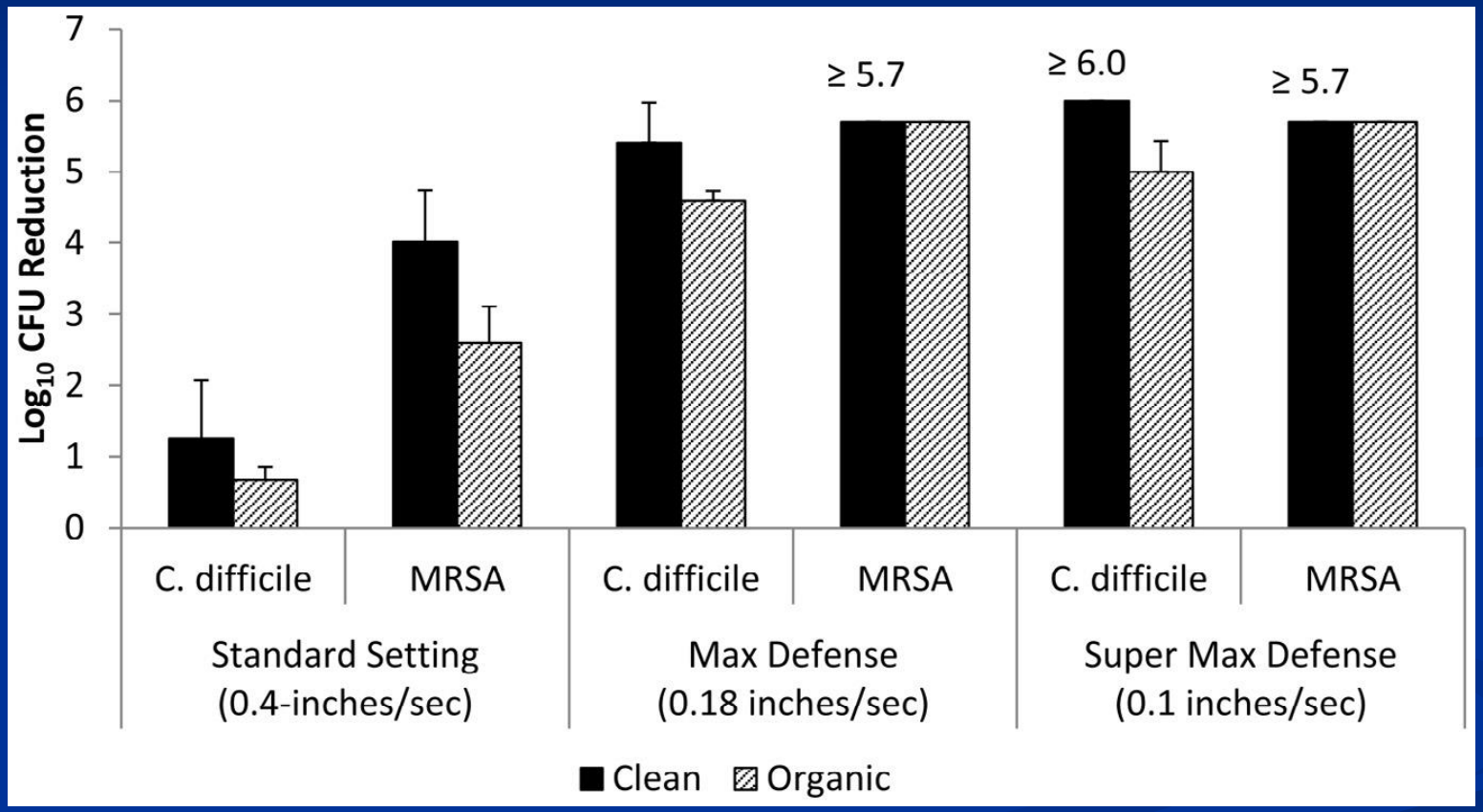
Nerandzic MM, et al. Infect Control Hosp Epidemiol 2014;36:192-7

# Disinfection of mobile hand held devices

- Enclosed box
- Conveyer belt (.4 in/sec)
- UV-C in close proximity to mobile handheld devices
- Time for disinfection: cell phone, 15 sec; iPAD 50 sec

Matthew JI. Evaluation of an enclosed UV-C device for decontamination of mobile handheld devices. Am J Infect Control 2016;44:724-6

# Log reductions with UV box used for disinfection of hand held devices

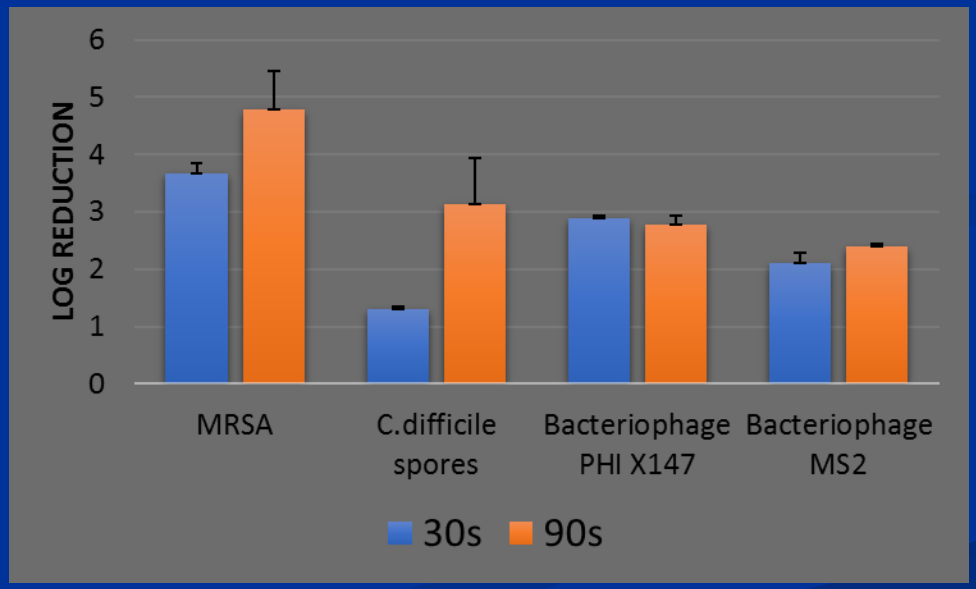



Matthew JI. Evaluation of an enclosed UV-C device for decontamination of mobile handheld devices. Am J Infect Control 2016;44:724-6

# Keyboard decontamination

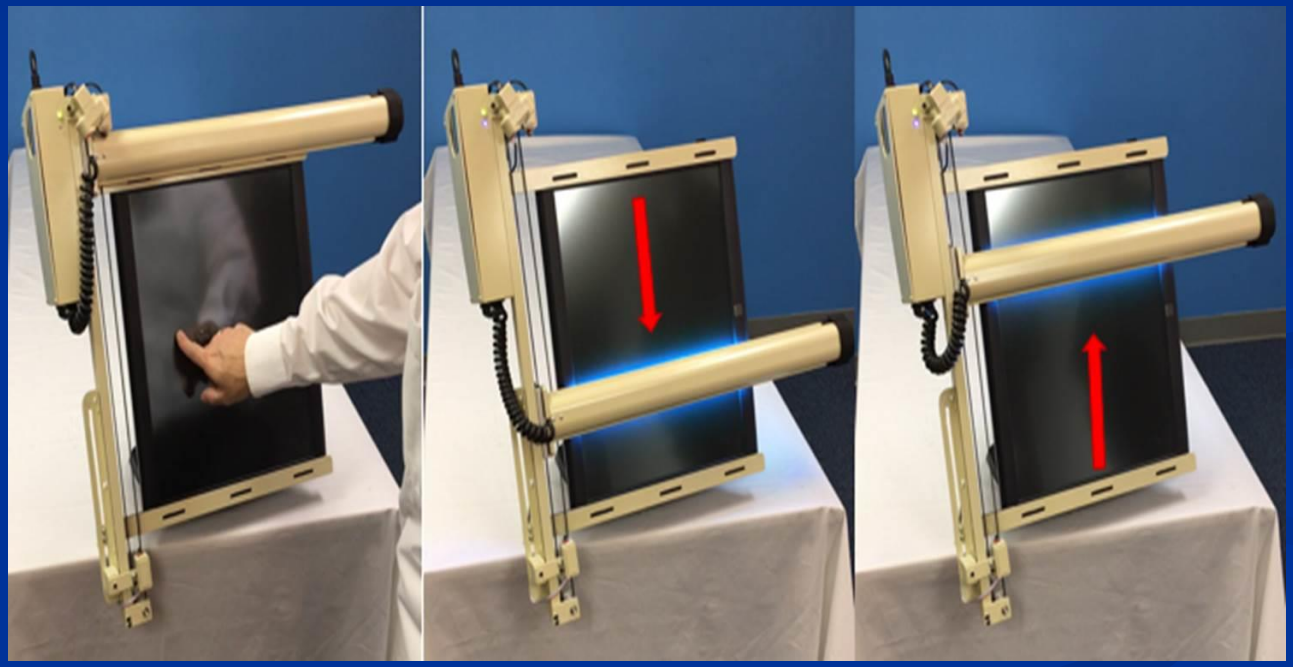
Keyboard with automated UV-C decontamination

Log reduction MRSA




Alhmidi H. Evaluation of an enclosed UV-C Radiation Device for Decontamination of Keyboards SHEA 2018.

# Automated touchscreen decontamination with UV-C



Alhimidi H. Evaluation of an automated ultraviolet-C light disinfection device and patient hand hygiene for reduction of pathogen transfer from interactive touchscreen computer kiosks. AJIC 2018;146:464-467

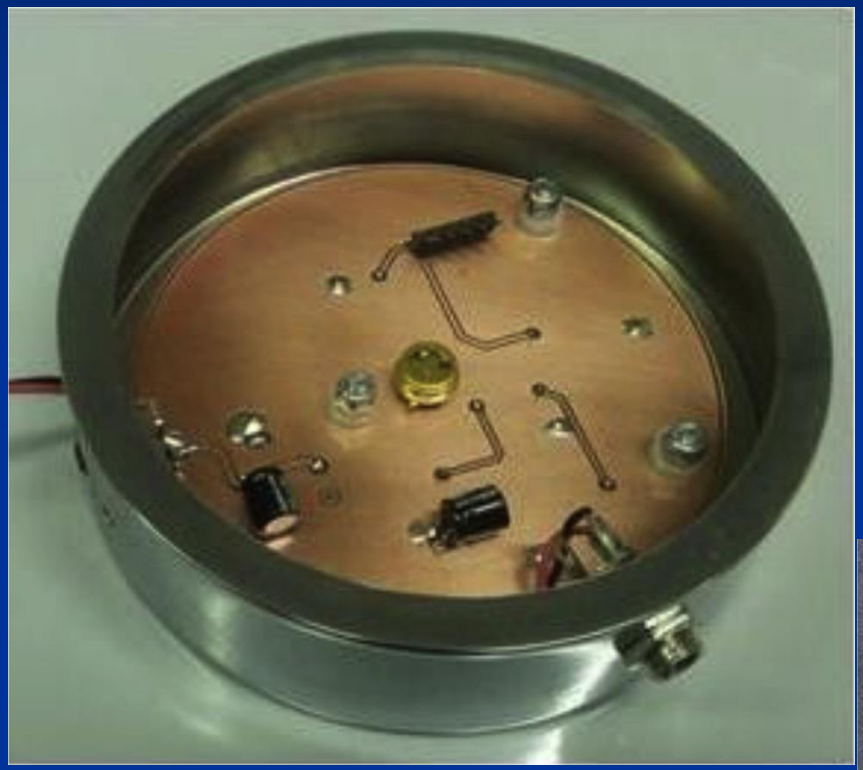
# Shared pens and styluses

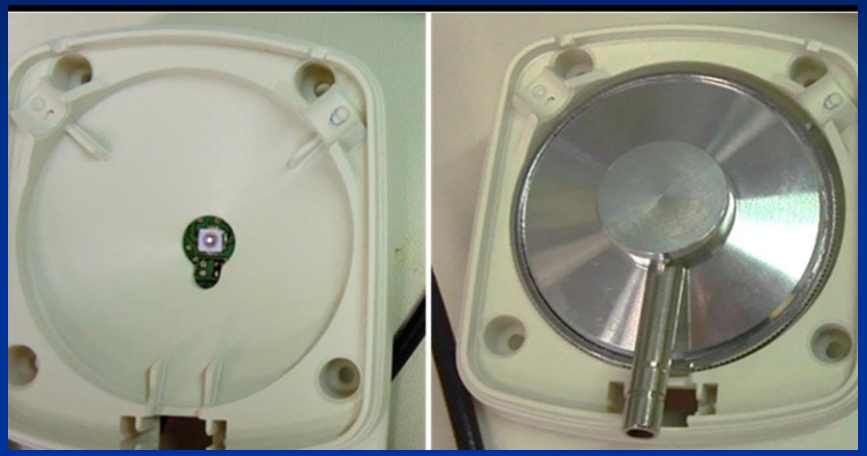
- Pens and styluses are often shared in healthcare settings
- Inoculation of a shared pen in a waiting room resulted in dissemination of a benign virus throughout the clinic[1]
- An LED (light-emitting diode) UV-C device was effective in reducing pen contamination[2]

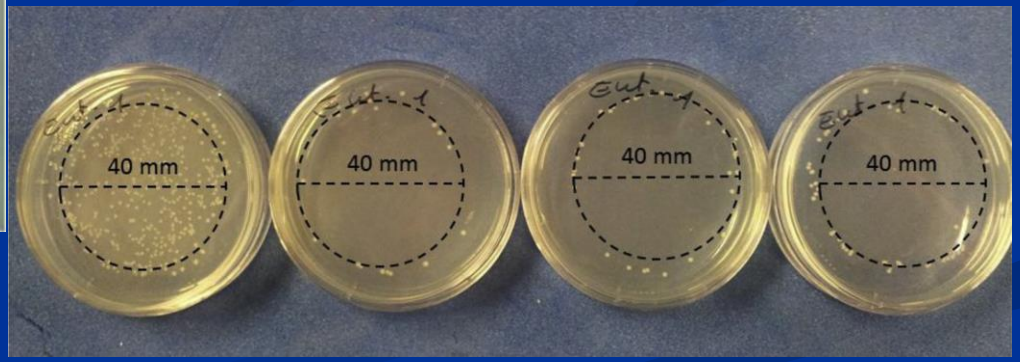
https://youtu.be/JqsQWpT62rw

1. Reynolds K. The dynamics of microbe spread via hands and fomites throughout an outpatient clinic. ID Week 2017; 2. Cadnum JL. Unpublished data.

# UV-C emitted by light emitting diodes (LEDs) for stethoscope decontamination



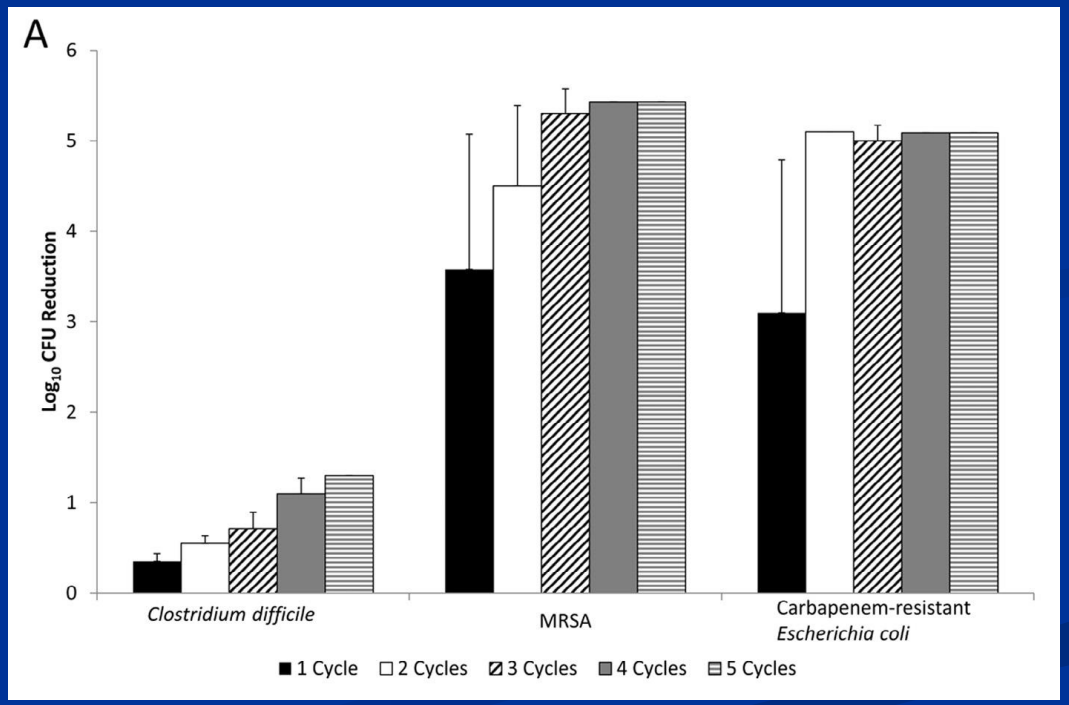





Messina G. Int. J. Environ. Res. Public Health 2016;13:940

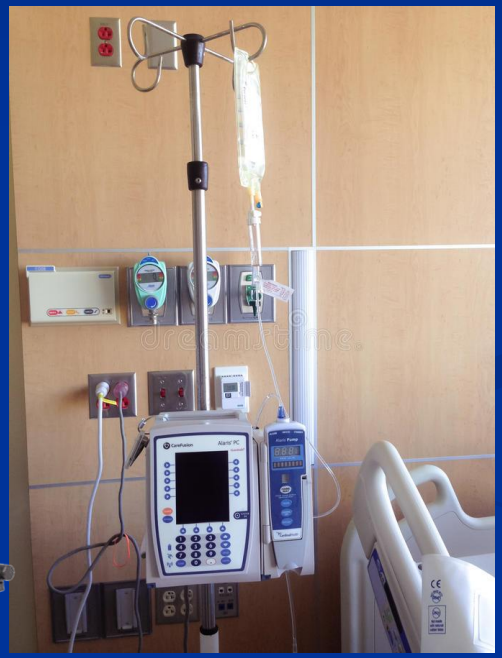
# Low-intensity UV-C for keyboard decontamination

**Reduction 4 inches from bulb**




Shaikh AA. Evaluation of a low-intensity ultraviolet-C radiation device for decontamination of computer keyboards. Am J Infect Control 2016;44:705-7

# Spray products

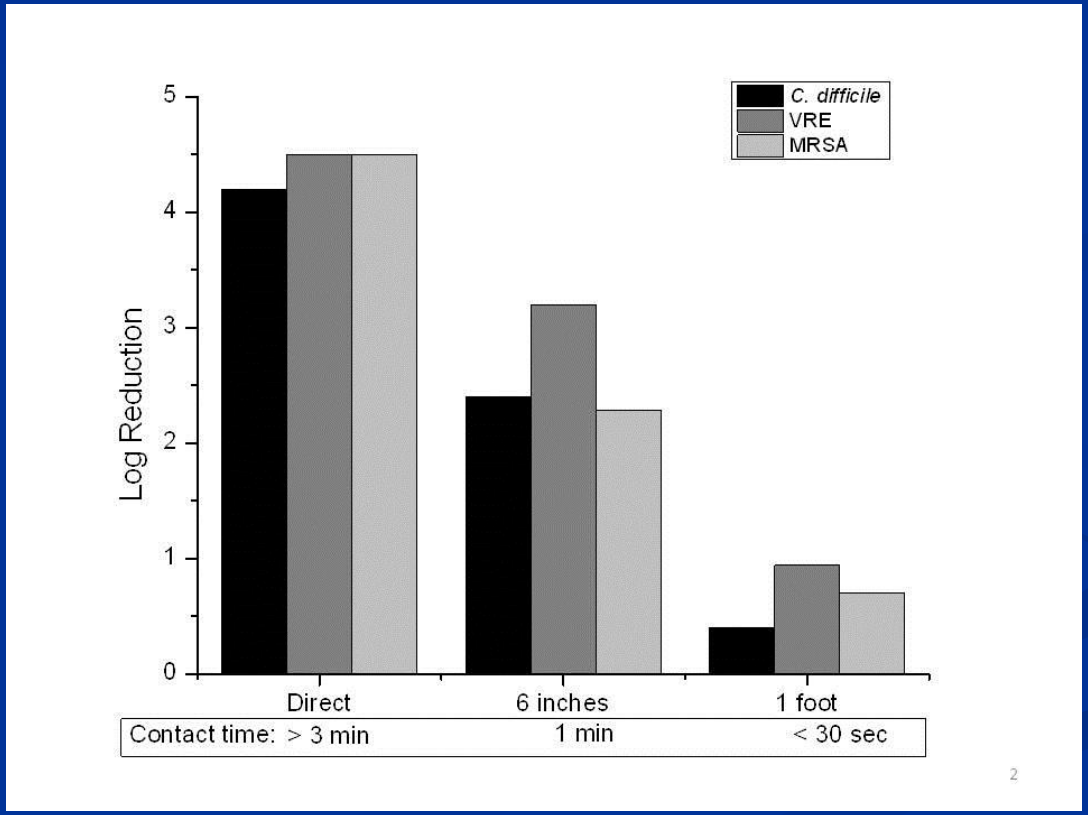


# Hydrogen peroxide mist


- Sporicidal
- Requires protective equipment
- Operator dependent

# Limitation of spray products: Inadequate application reduces efficacy

Effectiveness of a spray product versus distance from direct point of spray

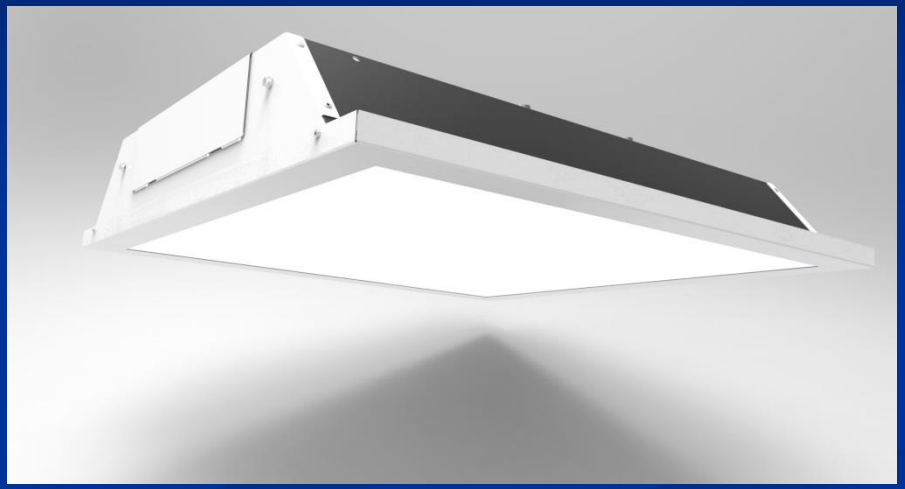



Deshpande A, et al. ID Week 2013

# Continuous disinfection

# High-intensity visible light

- Blue-violet light (~405-415 nm) generated through light emitting diodes
- Safe to use in occupied rooms
- Replace standard lighting
- Limited effectiveness (0.5 to 1 log reduction in MRSA and *E. coli* in 24 hours)

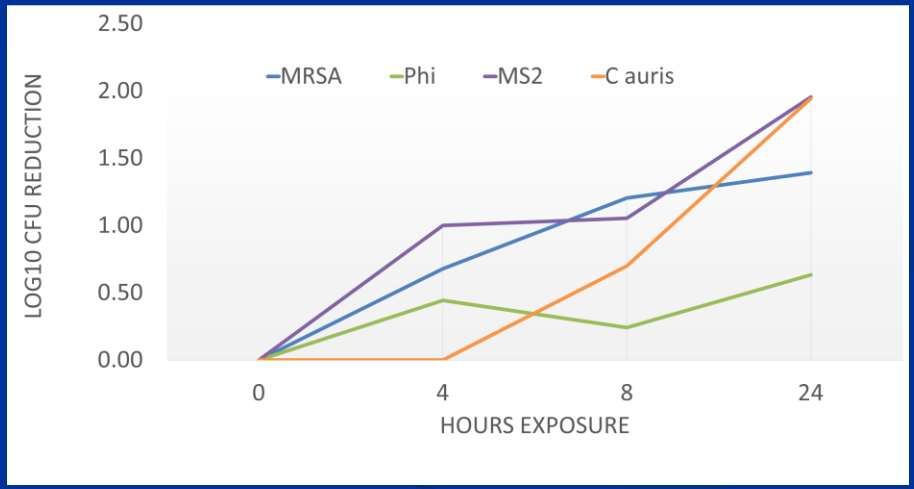


Maclean M. Environmental decontamination of a hospital room using high-intensity narrow-spectrum light. JHI 2010;76:247-51; Bache SE. Clinical studies of the high-intensity narrow-spectrum light environmental decontamination system, for continuous disinfection in the burn unit inpatient and outpatient setting. Burns 2012;38:69-76; Maclean M. Sporicidal effects of high-intensity 405 nm visible light on endospore-forming bacteria. Photochemistry and Photobiology 2013;89:120-6; Dai T. Blue light rescues mice from potentially fatal *P aeruginosa* burn infection: efficacy, safety, and mechanism of action. Antimicrob Agents Chemother 2013; Cadnum JL. Efficacy of a Visible Light Disinfection System Against Healthcare-Associated Pathogens. SHEA 2016.

# Ultraviolet-A light (315-400 nm) for continuous room disinfection

**UV-A**

- Proposed as a safe method to provide continuous disinfection in occupied rooms up to 8 h per day
- At the intensity proposed for use in patient rooms (3 w/m2), MRSA, *E. coli*, and bacteriophage MS2 reduced by >1.2 logs after 24 hours



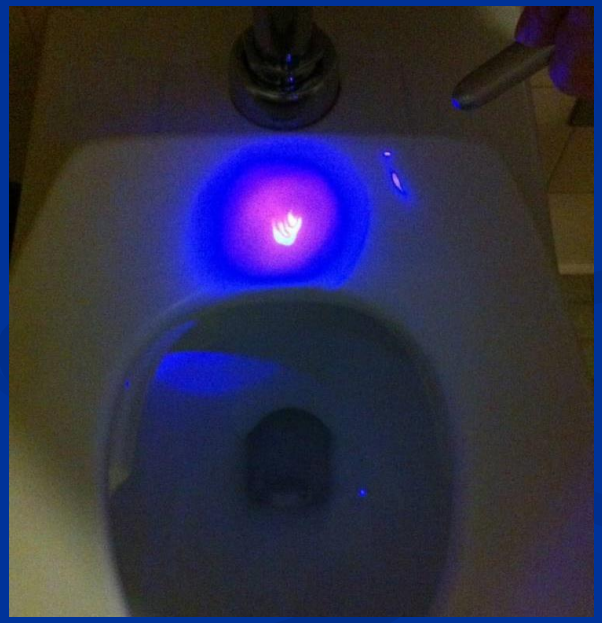

Livingston S. SHEA 2018.

# Monitoring cleaning

# Fluorescent markers

Phil Carling

Fluorescent marker on a toilet seat after housekeeping cleaning



1. Carling PC, et al. Clin Infect Dis 2006;42:385-8; 2. Carling P, et al. Infect Control Hosp Epidemiol 2008;29:1035-41; 3. Carling P. Am J Infect Control 2013;41:520-525

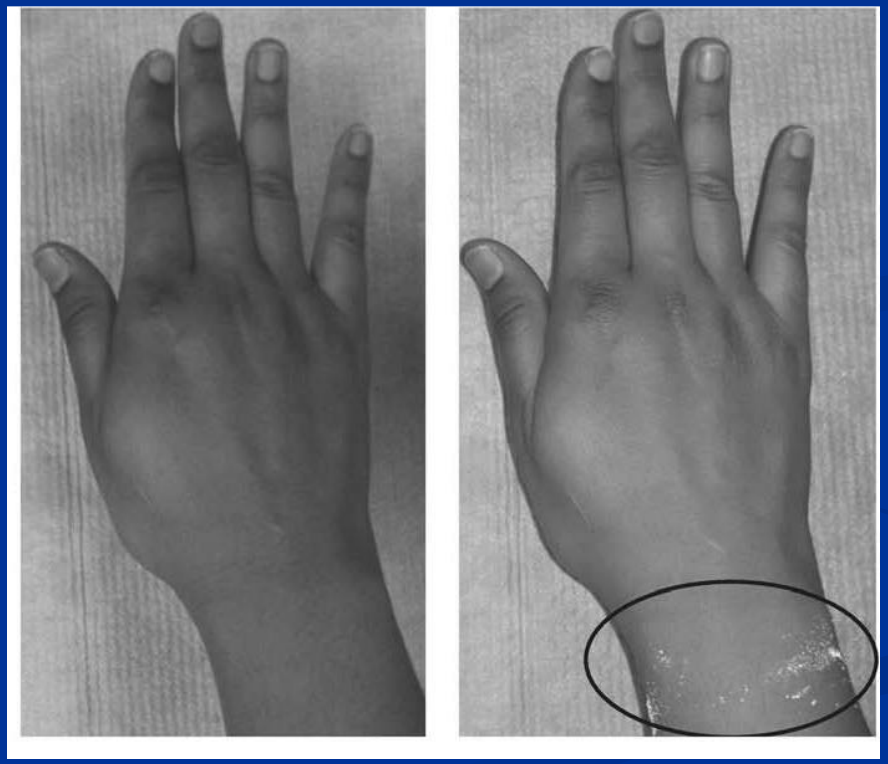
# Low-cost fluorescent marker: Tide free & gentle laundry detergent

# Fluorescent marker spray

- Liquid spray fluorescent marker
- Detected by black light
- 200 sprays per tube

# A novel reflective marker visualized by flash photography

No flash With flash



Tomas ME. Utility of a Novel Reflective Marker Visualized by Flash Photography for Assessment of Personnel Contamination During Removal of Personal Protective Equipment. ICHE 2016;37:711-3

# Chemical additive to colorize chlorine-based disinfectants to improve visualization


Mustapha A. Evaluation of novel chemical additive that colorizes chlorine-based disinfectants to improve visualization of surface coverage. AJIC 2018;46:119-121.

# Summary

- Application of UV-C expanding beyond hospital rooms
  - Automation, proximity, LEDs, low-intensity devices used while people are present
- Spray products
- Continuous disinfection
  - High-intensity visible light, UV-A
- New monitoring tools